```
         ┌──────────────────────┐
         │ PATIENT DESIGNATES   │  100
         │      COMPLAINT       │
         └──────────────────────┘
                    │
         ┌──────────────────────┐
         │  STRUCTURED DATA     │  104
         │  ENTRY BY PATIENT    │
         │      BASED ON        │
         │ DESIGNATED COMPLAINT │
         └──────────────────────┘
                    │
         ┌──────────────────────┐
         │  DISEASE SIGNATURE   │  108
         │     IDENTIFIED       │
         └──────────────────────┘
                    │
              ◇ 112
          DR. DESIRES              ┌──────────────────────────┐
          REVIEW OF      ──YES──▶  │ PATIENT DATA PROVIDED     │  116
          DATA                     │      TO DR. FOR           │
              │                    │   PRE-EXAM REVIEW         │
             NO                    └──────────────────────────┘
              │
         ┌──────────────────────┐
         │  DR. GENERATES       │  120
         │ NATURAL LANGUAGE     │
         │ EXAMINATION REPORT   │
         └──────────────────────┘
                    │
         ┌──────────────────────┐
         │  NATURAL LANGUAGE    │  124
         │  REPORT PROCESSED    │
         └──────────────────────┘
                    │
              ◇ 128
          CORRECTIONS             ┌──────────────────────┐
          REQUIRED       ──YES──▶ │    DR. EDITS         │  132
              │                   │  STRUCTURED DATA     │
             NO                   └──────────────────────┘
              │
         ┌──────────────────────┐
         │  STRUCTURED DATA     │  136
         │  FRAMES GENERATED    │
         └──────────────────────┘
                    │
         ┌──────────────────────┐
         │  STRUCTURED DATA     │  140
         │  FRAMES ADDED        │
         │ TO APPROPRIATE       │
         │   DATABASE (S)       │
         └──────────────────────┘
```

FIG.1

PATIENT ID: _____ AGE: ____ SEX: ____ PROCEDURE ID: _____ DATE: _____

PATIENT INFORMATION

NAME

ADDRESS

HOME PHONE
WORK PHONE

E-MAIL

GENDER ☐ MALE ☐ FEMALE

BIRTH DATE
MONTH DAY YEAR

RACE/ETHNICITY
☐ WHITE/CAUCASIAN ☐ AFRICAN AMERICAN ☐ HISPANIC/LATINO
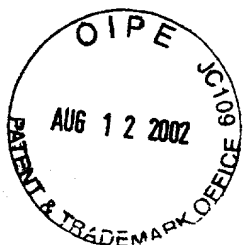☐ ASIAN/PACIFIC ISLANDER ☐ NATIVE AMERICAN ☐ MULTIRACIAL
☐ OTHER

MARITAL STATUS
☐ SINGLE ☐ LIVING WITH ANOTHER ☐ MARRIED
☐ SEPARATED ☐ DIVORCED ☐ WIDOWED

EDUCATION LEVEL
☐ HIGH SCHOOL OR LESS ☐ VOCATIONAL/TECHNICAL ☐ COLLEGE DEGREE
☐ GRADUATE DEGREE ☐ PROFESSIONAL DEGREE

OCCUPATIONAL STATUS
☐ EMPLOYED ☐ STUDENT ☐ RETIRED
☐ UNEMPLOYED

INSURANCE/BILLING
1. _____ 2. _____

FIG.2

PATIENT ID: _____ AGE: _____ SEX: _____ PROCEDURE ID: _____ DATE: _____

REASON FOR VISIT ☐ ROUTINE (E.G., CHECKUP) ☐ 1ST VISIT TO THIS PHYSICIAN, OR NEW MEDICAL CONDITION ☐ FOLLOW-UP FOR EXISTING MEDICAL CONDITION

REFERRED BY: ☐ PRIMARY CARE PHYSICIAN ☐ ANOTHER SPECIALIST ☐ SELF

REFERRING DIAGNOSIS [   ]

[ICD - 9 CODES] | 1. | 2. | 3. |

PHENOMENON CATEGORY
☐ LUMP/BUMP   ☐ DISCHARGE/LEAK   ☐ BLEEDING
☐ WRONG DIRECTION ☐ DISCOLORATION   ☐ INTAKE DIFFICULTY

OTHER PHENOMENON CATEGORY [   ]

IF YOU ARE EXPERIENCING A NEW MEDICAL PROBLEM, SYMPTOM, OR CONDITION, PLEASE FILL OUT THE FOLLOWING:

CHIEF COMPLAINT [   ]

SYMPTOM DURATION

SYMPTOM QUANTITY (DISEASE-SPECIFIC)

SYMPTOM TIMING (DISEASE-SPECIFIC)

SYMPTOM CONTEXT

SYMPTOM QUALITY

RELEVANT PAST HX
PREVIOUS CONSULT WITH ANOTHER PHYSICIAN   ☐ YES   ☐ NO
RECEIVED MEDICAL TREATMENT FOR THIS CONDITION   ☐ YES   ☐ NO
PREVIOUS SURGERY FOR THIS CONDITION   ☐ YES   ☐ NO
OTHER [   ]

RELEVANT FAMILY HX (DISEASE-SPECIFIC) [   ]

IF THIS IS A FOLLOW-UP VISIT, PLEASE ANSWER THE FOLLOWING:

SYMPTOM EVOLUTION (PER SYMPTOM)
☐ GONE AWAY COMPLETELY ☐ IMPROVED   ☐ NO CHANGE
☐ WORSE

FIG.3

PATIENT ID:_____ AGE:_____ SEX:_____ PROCEDURE ID:_____DATE:_____

ARE YOU EXPERIENCING ANY OF THE FOLLOWING PROBLEMS?	☐WEIGHT LOSS ☐WEIGHT GAIN	☐FEVER	☐FATIGUE	CONSTITUTIONAL
DO YOU HAVE LAZY EYE?	☐YES	☐NO		EYE PROBLEMS
ANY NEW VISION/EYE PROBLEMS?	☐YES	☐NO		
IF YES, PLEASE CHECK...	☐BLURRED VISION ☐EYE PAIN	☐DOUBLE VISION ☐EYE REDNESS	☐LOSS OF VISION ☐EYE DRYNESS	
ARE YOU HAVING HEARING, BALANCE, SPEECH OR THROAT PROBLEMS?	☐YES	☐NO		EAR/NOSE/THROAT
IF YES, PLEASE CHECK...	☐TROUBLE HEARING ☐LOSS OF BALANCE ☐HOARSENESS	☐RINGING IN EAR(S) ☐EAR PAIN ☐TROUBLE SWALLOWING	☐DIZZINESS ☐EAR DISCHARGE ☐SLURRED SPEECH	
HAVE YOU BEEN TOLD YOU HAVE A HEART MURMUR?	☐YES	☐NO		CARDIOVASCULAR
ARE YOU EXPERIENCING ANY CHEST PAIN, HEART PROBLEMS, LIMB PAIN, OR FAINTING?	☐YES	☐NO		
IF YES, PLEASE CHECK...	☐CHEST PAIN ☐FAINTING	☐LIMB SWELLING ☐LIMB PAIN ON WALKING	☐FAST HEART BEAT ☐IRREGULAR HEART BEAT	
DO YOU HAVE ASTHMA?	☐YES	☐NO		RESPIRATORY
ARE YOU HAVING PROBLEMS BREATHING, COUGHING, OR COUGHING UP ANYTHING?	☐YES	☐NO		
IF YES, PLEASE CHECK...	☐TROUBLE BREATHING	☐CHRONIC COUGH	☐COUGHING BLOOD	
ARE YOU HAVING ANY STOMACH OR DIGESTIVE PROBLEMS?	☐YES	☐NO		GASTROINTESTINAL
IF YES, PLEASE CHECK...	☐INDIGESTION ☐NAUSEA ☐DIARRHEA	☐HEART BURN ☐VOMITING ☐CONSTIPATION	☐ABDOMINAL PAIN ☐REGURGITATION ☐BLOODY STOOLS	

FIG.4

ARE YOU HAVING ANY PROBLEMS URINATING?	☐ YES	☐ NO		GENITOURINARY
IF YES, PLEASE CHECK...	☐ INCONTINENCE ☐ EXCESSIVE URINATION	☐ PAIN ON URINATION	☐ BLOOD IN URINE	
ARE YOU HAVING MUSCLE OR JOINT PROBLEMS OR PAIN ANYWHERE?	☐ YES	☐ NO		MUSCULOSKELETAL
IF YES, PLEASE CHECK...	☐ JOINT SWELLING ☐ JOINT PAIN ☐ JOINT STIFFNESS	☐ MUSCLE PAIN ☐ MUSCLE CRAMP ☐ MUSCLE TWITCHES	☐ BACK PAIN ☐ NECK PAIN ☐ LOSS OF MUSCLE	
ARE THERE ANY CHANGES TO YOUR SKIN, HAIR, SENSE OF FEEL, OR SWEATING?	☐ YES	☐ NO		SKIN & BREAST
IF YES, PLEASE CHECK...	☐ NUMBNESS ☐ HAIR LOSS ☐ SKIN RASH	☐ TINGLING ☐ NAIL CHANGES ☐ DRY EYES/MOUTH	☐ DISCOLORATION ☐ SWEATING CHANGES	
ARE YOU HAVING HEADACHES/ HEAD PAIN, BLACKOUTS, COORDINATION PROBLEMS OR MEMORY PROBLEMS?	☐ YES	☐ NO		NEUROLOGIC
IF YES, PLEASE CHECK...	☐ HEADACHE ☐ WEAKNESS ☐ BLACKOUTS	☐ FACE PAIN ☐ TREMORS ☐ TROUBLE WITH MEMORY	☐ FACE NUMBNESS ☐ CLUMSINESS ☐ TROUBLE CONCENTRATING	
ARE YOU HAVING ANY PSYCHOLOGICAL ISSUES OR PROBLEMS WITH SLEEP?	☐ YES	☐ NO		PSYCHIATRIC
IF YES, PLEASE CHECK...	☐ HALLUCINATIONS ☐ SUICIDAL THOUGHTS	☐ FEELING DEPRESSED ☐ INAPPROPRIATE CRYING	☐ TROUBLE SLEEPING ☐ INAPPROPRIATE LAUGHING	
ARE YOU BLEEDING OR HAVE FOUND ANY LUMPS/SWELLING THAT ARE NEW?	☐ YES	☐ NO		HEMATOLOGIC/ LYMPHATIC
	☐ ABNORMAL BLEEDING	☐ NOSE BLEEDS	☐ LUMPS OR SWELLINGS	
DO YOU HAVE ANY OF THE OTHER FOLLOWING SYMPTOMS?	☐ EXCESSIVE THIRST	☐ HEAT/COLD INTOLERANCE		ENDOCRINE

FIG.5

NATURAL
LANGUAGE
REPORT ___ 600

STRUCTURAL
ANALYZER ___ 610

LEXICAL
ANALYZER ___ 620

PARSER/
SEMANTIC
INTERPRETER ___ 630

FRAME
GENERATOR ___ 650

STRUCTURED
DATA
FRAMES ___ 660

FIG.6

START

DEFINE REPORT TYPE AND DOMAIN — 700

WHILE (MORE WORDS) — NO

YES

GET NEXT WORD OF SENTENCE — 710

DOMAIN SPECIFIC LEXICON → LOOK UP WORD IN LEXICONS ← GENERIC LEXICON — 720

WORD IDENTIFIED ? — YES → MULTIPLE SENSES FOUND ? — NO

MULTIPLE SENSES FOUND ? — YES → DO WORD SENSE DISAMBIGUATION — 725

WORD IDENTIFIED ? — NO → DO SPECIAL SYMBOL PROCESSING — 730

WORD IDENTIFIED ? — YES

WORD IDENTIFIED ? — NO → DO MORPHOLOGY ANALYSIS — 740

WORD IDENTIFIED ? — YES

WORD IDENTIFIED ? — NO → DO BEST GUESS ALGORITHM — 750

END WHILE

END

FIG.7

DEFINE DEMAND
FOR EXAMINATION
REPORTING — 800

COLLECT
REFERENCE — 820
MATERIALS

COLLECT TRAINING — 810
CORPORA

COMPILE INDEX — 824
OF TERMS

SEARCH FOR — 828
TERMS IN
LEXICON

CURRENT
LEXICON

PROCESS EACH — 815
WORD USING
LEXICAL ANALYZER

WORD
FOUND
?

YES

NO

ASSIGN — 840
CONCEPTID,
SEMANTIC CLASS,
SYNTACTIC CLASS

INSERT WORD AND — 830
ITS SENTENCE INTO
UNKOWN WORDS
DATABASE

EXPERT — 844
VERIFICATION

MANUAL EXPERT — 834
CLASSIFICATION
OF WORD

ADD NEW WORD — 848
SENSE TO
CURRENT LEXICON
AS NEEDED

INSERT WORD — 838
INTO CURRENT
LEXICON

FIG.8

THE | WELL-DEMARCATED | MASS | IN | THE | RIGHT | APEX | MEASURING | 8CM | IS | AGAIN | NOTED

FIG.9A

predicate	head	relation	value
hasArticle	mass	EQUALS	the
hasBorderDef	mass	EQUALS	well-demarcated
hasLocation	mass	in	apex
hasDirection	apex	EQUALS	right
hasSize	mass	measuring	8cm
hasTempMod	noted	EQUALS	again
hasAuxillary	noted	EQUALS	is
hasExistence	mass	EQUALS	noted

FIG.9B

INPUT: CANDIDATE

LOGICAL RELATION

WITH CONTEXT $\vec{b}$

CLASSIFIER FOR
A GIVEN LOGICAL
RELATION
$p(a|\vec{b})$

OUTPUT: PROBABILITY THAT

LOGICAL RELATION IS TRUE GIVEN

CONTEXT $\vec{b}$.

FEATURES,
WEIGHTS AND
FUNCTIONAL FORM
OF CLASSIFIER
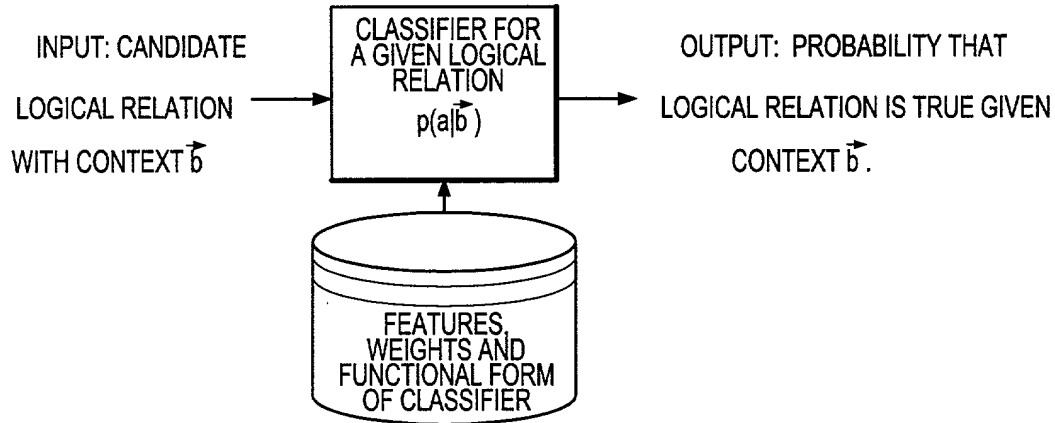
FIG.10A

MAXIMUM ENTROPY MODEL USED FOR PARSER/SEMANTIC INTERPRETER

$$p(a|\vec{b}) = \frac{1}{Z(\vec{b})} \cdot \exp\left\{\sum_{1}^{n} \lambda_i f_i(a,\vec{b})\right\}$$

λ_i = WEIGHTING FACTOR FOR FEATURE i (COMPUTED FROM TRAINING EXAMPLE STATISTICS)

$Z(\vec{b})$ = NORMALIZATION FACTOR TO ASSURE THAT THE PROBABILITY IS WITHIN THE RANGE 0.0 TO 1.0

FIG.10B

(i) $\quad f(a,\vec{b}) = \begin{cases} 1 & \text{if}(a=1) \ \& \ (b_2=\text{TRUE} \ \& \ b_6=\text{TRUE} \ \& \ b_8=\text{FALSE}) \\ 0 & \text{OTHERWISE} \end{cases}$

(ii) $\quad f(a,\vec{b}) = \begin{cases} 1 & \text{if}(a=0) \ \& \ (b_2=\text{FALSE} \ \& \ b_1=\text{TRUE} \ \& \ b_8=\text{TRUE}) \\ 0 & \text{OTHERWISE} \end{cases}$

FIG.10C

	THE	OSSEUS	AND	SOFT TISSUE	STRUCTURES	OF	THORAX	DEMONSTRATE	CHANGE
THE	◯			Ⓗ	Ⓗ		Ⓗ		Ⓗ
OSSEUS		◯	Ⓡ		Ⓗ				Ⓗ
AND			◯	Ⓗ					
SOFT TISSUE				◯	Ⓗ		Ⓗ		Ⓗ
STRUCTURES					◯				
OF					Ⓗ	◯			
THORAX						Ⓡ	◯		
DEMONSTRATE				Ⓗ	Ⓗ		Ⓗ	◯	
CHANGE						Ⓡ		Ⓡ	◯

FIG.11A

	THE	OSSEUS	AND	SOFT TISSUE	STRUCTURES	OF	THORAX	DEMONSTRATE	CHANGE
THE	○			0.42	0.89		0.13		0.05
OSSEUS		○	0.78		0.74				0.28
AND			○	0.78			0.31		
SOFT TISSUE				○	0.91		0.42		0.31
STRUCTURES					○				
OF					0.95	○			
THORAX						0.95	○		
DEMONSTRATE				0.68	0.78		0.65	○	
CHANGE						0.29		0.92	○

FIG.11B
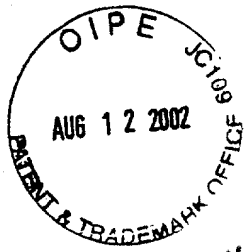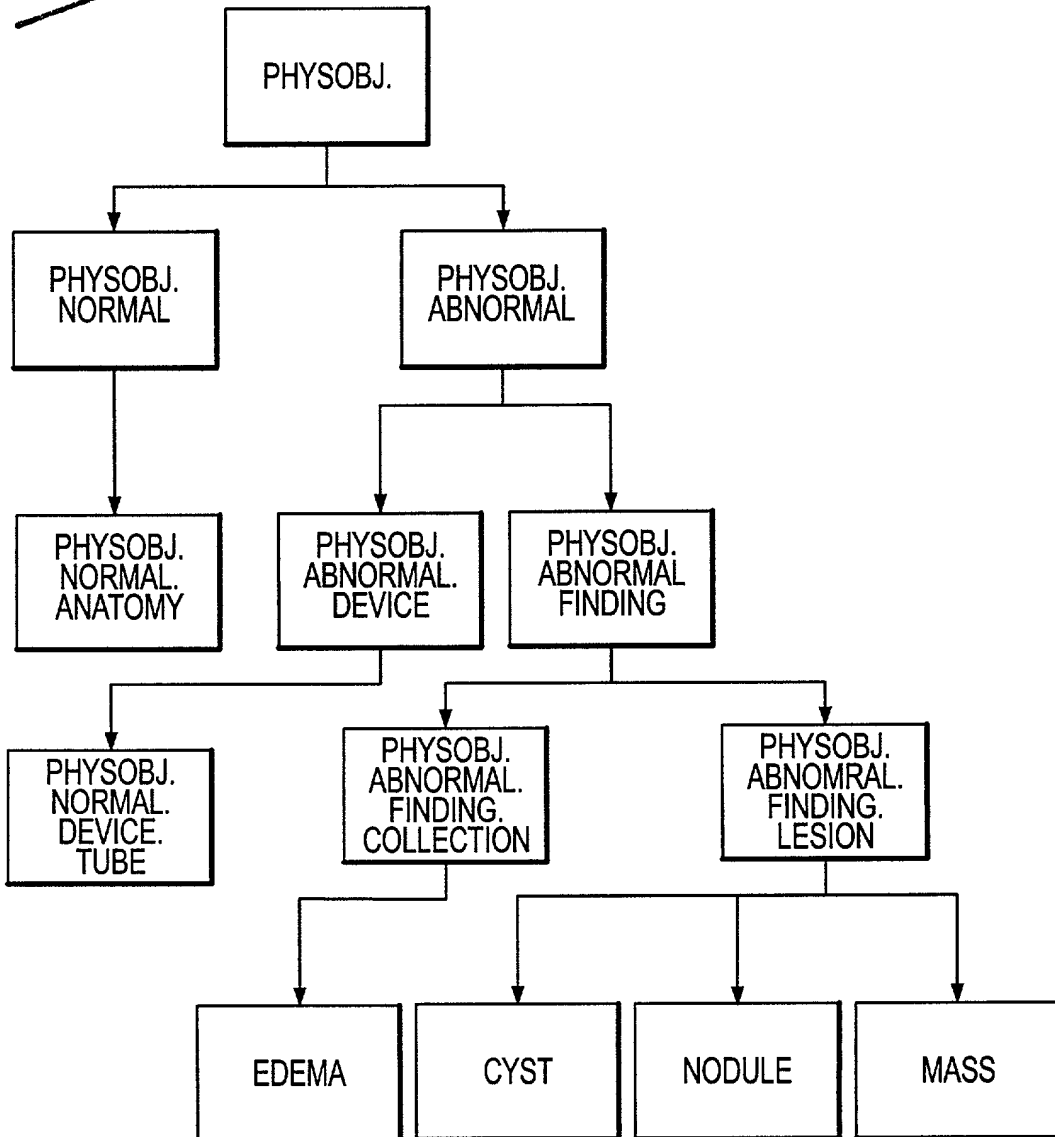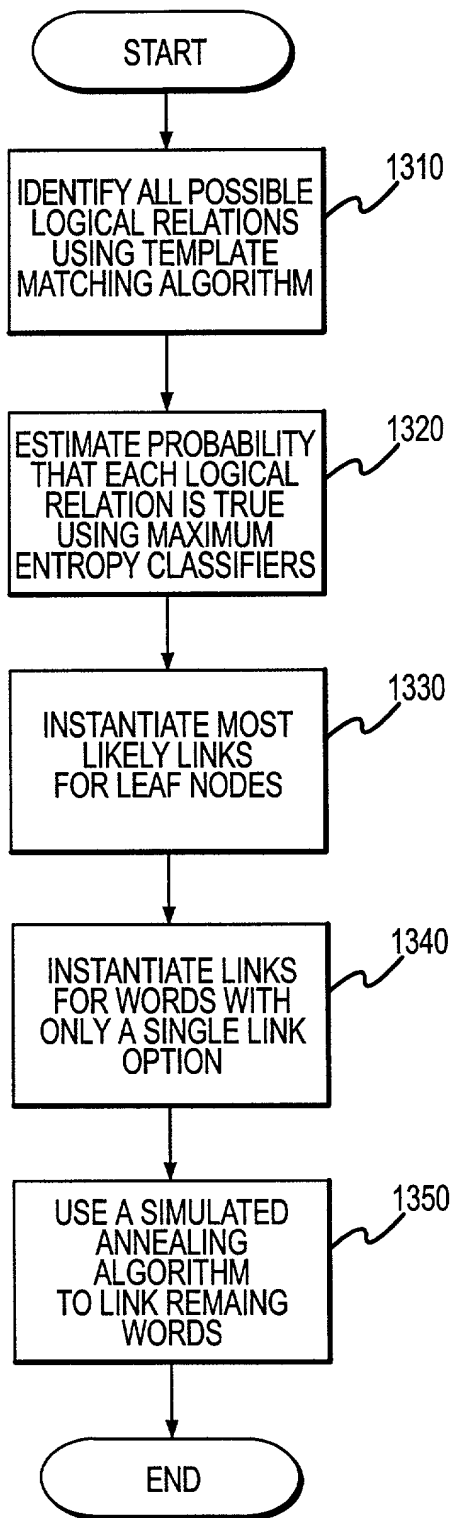
```
                          ┌─────────────┐
                          │  PHYSOBJ.   │
                          └──────┬──────┘
                     ┌───────────┴───────────┐
              ┌──────┴──────┐         ┌───────┴──────┐
              │  PHYSOBJ.   │         │  PHYSOBJ.    │
              │  NORMAL     │         │  ABNORMAL    │
              └──────┬──────┘         └───────┬──────┘
                     │             ┌──────────┴──────────┐
              ┌──────┴──────┐ ┌────┴──────┐      ┌───────┴──────┐
              │  PHYSOBJ.   │ │ PHYSOBJ.  │      │  PHYSOBJ.    │
              │  NORMAL.    │ │ ABNORMAL. │      │  ABNORMAL    │
              │  ANATOMY    │ │ DEVICE    │      │  FINDING     │
              └─────────────┘ └────┬──────┘      └───────┬──────┘
                                   │                     │
              ┌──────────┐  ┌──────┴────────┐   ┌────────┴───────┐
              │ PHYSOBJ. │  │  PHYSOBJ.     │   │  PHYSOBJ.      │
              │ NORMAL.  │  │  ABNORMAL.    │   │  ABNOMRAL.     │
              │ DEVICE.  │  │  FINDING.     │   │  FINDING.      │
              │ TUBE     │  │  COLLECTION   │   │  LESION        │
              └──────────┘  └──────┬────────┘   └────────┬───────┘
                               ┌───┴───┐        ┌────────┼─────────┐
```

EDEMA	CYST	NODULE	MASS

FIG.12

```
         ┌──────────┐
         │  START   │
         └──────────┘
              │
              ▼
   ┌────────────────────┐
   │ IDENTIFY ALL POSSIBLE │ ── 1310
   │ LOGICAL RELATIONS    │
   │ USING TEMPLATE       │
   │ MATCHING ALGORITHM   │
   └────────────────────┘
              │
              ▼
   ┌────────────────────┐
   │ ESTIMATE PROBABILITY │ ── 1320
   │ THAT EACH LOGICAL    │
   │ RELATION IS TRUE     │
   │ USING MAXIMUM        │
   │ ENTROPY CLASSIFIERS  │
   └────────────────────┘
              │
              ▼
   ┌────────────────────┐
   │ INSTANTIATE MOST     │ ── 1330
   │ LIKELY LINKS         │
   │ FOR LEAF NODES       │
   └────────────────────┘
              │
              ▼
   ┌────────────────────┐
   │ INSTANTIATE LINKS    │ ── 1340
   │ FOR WORDS WITH       │
   │ ONLY A SINGLE LINK   │
   │ OPTION               │
   └────────────────────┘
              │
              ▼
   ┌────────────────────┐
   │ USE A SIMULATED      │ ── 1350
   │ ANNEALING            │
   │ ALGORITHM            │
   │ TO LINK REMAING      │
   │ WORDS                │
   └────────────────────┘
              │
              ▼
         ┌──────────┐
         │   END    │
         └──────────┘
```

FIG.13

Present	Findings	Size	Location	Growth Trend

1410

1420

1440

1440

FIG.14
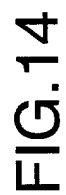
NLP Finding

Entity ID: 'mass'

Entity Class: FINDING Abnormal.lesion

Existence

Currently

Attribute	Value
How Determined	by observation
Certainty of Existence	certain
Relevancy of Note	significant

Change (t2-Currently, t1=previous exam)

Attribute	Value
Direction of Change	stable, still exists
Magnitude of Change	no change in existence

Location

Spatial-Relation	Anatomy Description	Standardized Anatomy Description
'in'	right apex	apex of right upper lobe of lung

State

Current

Size

Dimension	Relation	Value	Units	Precision
Diameter	=	8	cm	Approximately

external architecture

Dimension	Relation	Value	Units	Precision
border definition	=	well demarcated	n/a	n/a

FIG.15